Highlands Council
New Jersey

Air Quality Assessment

2008

Prepared by State of New Jersey Highlands Water Protection and Planning Council in Support of the Highlands Regional Master Plan

Technical Report

HIGHLANDS REGIONAL MASTER PLAN

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EXECUTIVE SUMMARY

The Highlands Water Protection and Planning Act requires a resource assessment of the Highlands Region to determine the amount and type of development in the Region which the ecosystem can sustain while protecting the valuable resources of the region. Air quality is one of the resources that must be assessed. This report provides an overview of air quality in New Jersey and the Highlands Region as well as an evaluation of air contaminant emissions, air quality trends, climate change, greenhouse gas emissions and health and environmental impacts of air contaminants in the Highlands Region. The report further provides federal and state control strategies and recommendations to improve air quality in the Highlands Region.

The evaluation of contaminant emissions for the Region was based on a review of the data from the New Jersey Department of Environmental Protection's (NJDEP's) 2002 Emissions Inventory. The analysis highlights sources of emissions and pollutants of concern in the Region. The recommendations considered in the report focus on sources of emissions and pollutants of concern.

INTRODUCTION

The Federal Clean Air Act (CAA) of 1970 and the Federal Clean Air Act Amendments (CAAA) of 1990, provide the legal jurisdiction for the States to address air quality. Under the CAA, the United States Environmental Protection Agency (USEPA) is required to set National Ambient Air Quality Standards (NAAQS) for pollutants that are harmful to public health and the environment. The USEPA has set NAAQS for six criteria pollutants, which include ozone (O_3), particulate matter (PM), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxides (NO_x) and lead (Pb).[1]

Of the six criteria pollutants, ozone, PM and SO_2 are pollutants of current concern in New Jersey. New Jersey currently attains the NAAQS for CO, nitrogen dioxide, (NO_2) and lead.

Pollutants that are emitted from sources within the state and transported from sources outside the state diminish air quality. Ozone and the pollutants that form ozone (especially NO_x) can be transported over long distances, following the pattern of the prevailing winds in the United States. This means that air quality problems associated with volatile organic compounds (VOC), and NO_x are not confined to areas where these pollutants are emitted.[2]

Currently, the entire State, including the seven counties that are part of the Highlands Region, is classified as nonattainment for the 8-hour ozone NAAQS. Thirteen counties in the State are in nonattainment for the fine particulate matter ($PM_{2.5}$) standard. Four counties in the Highlands Region are designated nonattaiment for the $PM_{2.5}$ standard based on their impacts on other counties with nonattainment monitors. Currently, there is one area in the State, a portion of Warren County, in nonattainment for SO_2 based on predicted effects of two power plants in Pennsylvania.

In addition to the nonattainment areas in the State for ozone, $PM_{2.5}$ and SO_2, New Jersey has one Class 1 area, the Brigantine Wilderness Area, of the Edwin B. Forsythe National Wildlife Refuge, that requires visibility protection under the CAA. Although this area is not located in the Highlands Region, it is similar with regard to its high level of environmental sensitivity.

New Jersey is one of a handful of states that currently has adopted legislation that addresses climate

[1] http://www.epa.gov/ttn/naaqs/

[2] http://www.epa.gov/air/urbanair/nox/chf.html

change concerns and recognizes air quality and green house gas emissions. In July 2007 Governor Corzine signed legislation adopting proactive and ambitious goals for the reduction of green house gas emissions in New Jersey. The legislation calls for reducing greenhouse gas emissions to 1990 levels by 2020, approximately a 20 percent reduction, followed by a further reduction of emissions to 80 percent below 2006 levels by 2050. New Jersey is only the third state in the nation to make greenhouse gas reduction goals law.

To reach this goal, the Commissioner of the Department of Environmental Protection (NJDEP) will work with the Board of Public Utilities (BPU), the Department of Transportation (NJDOT), the Department of Community Affairs (NJDCA) and other stakeholders to evaluate methods to meet and exceed the 2020 target reductions. The NJDEP Commissioner will make specific recommendations to meet the targets while taking into account the economic benefits and costs of implementing these recommendations. This evaluation will be done in conjunction with the state's pending Energy Master Plan, which will incorporate the new greenhouse gas reduction goal.

The State Energy Master Plan (52:27F-14) released by the Governor in 2008 requires that all levels of government plan and evaluate for energy efficiency and greenhouse gas reductions. The Main Goal of the Energy Master Plan is to empower the state of New Jersey to reduce projected energy use by 20% by 2020 and meet 20% of the State's electricity needs with Class 1 renewable energy sources by 2020. The combination of energy efficiency, conservation, and renewable energy resources, should allow New Jersey to meet any future increase in demand without increasing its reliance on non-renewable resources.

LEGAL REQUIREMENT FROM THE HIGHLANDS ACT

Section 11.a.(1)(a) of the Highlands Water Protection and Planning Act (Highlands Act) mandates that the regional master plan shall include:

11.a. (1)(a) A resource assessment which determines the amount and type of human development and activity which the ecosystem of the Highlands Region can sustain while still maintaining the overall ecological values thereof. Air Quality as listed specifically as a resource to be protected.

AIR QUALITY IN NEW JERSEY

SOURCES OF POLLUTION

Sources of pollution in New Jersey are from point, area and mobile sources. Point sources are stationary sources which include, but are not limited to, industrial sources and power plants. Area sources include consumer products and smaller stationary sources, such as dry cleaners. Mobile sources consist of onroad sources and nonroad sources. Onroad sources include cars and trucks. The Draft Regional Master Plan Transportation System Technical Report discusses the vehicular emissions analysis from the Highlands sub-regional transportation model. Nonroad sources include, but are not limited to, lawn mowers, construction equipment, trains and agriculture equipment.[3]

OZONE

Ozone occurs naturally in the upper regions of the atmosphere and is critical to shielding the Earth from harmful ultraviolet radiation. In the lower atmosphere, however, where the air we breathe lies, ozone is a harmful air pollutant, contributing to the formation of smog. Ground- level ozone is formed when the pollutants, volatile organic compounds (VOCs) and oxides of nitrogen (NO_x) emitted by automobiles, industrial facilities, gasoline vapors, chemical solvents and other sources react in the presence of sunlight.

[3] http://www.epa.gov/oar/oaqps/emissns.html#about

Ozone pollution is especially of concern during the summer months when the weather conditions needed to form elevated levels of ground-level ozone normally occur. [4]

The USEPA has designated two nonattainment areas for ozone in New Jersey under the 8-hour ozone standard, the Northern New Jersey-New York-Connecticut Nonattainment Area and the Southern New Jersey-Philadelphia-Delaware Nonattainment Area. The seven counties that comprise the Highlands Region are located in the Northern New Jersey-New York-Connecticut Ozone Nonattainment Area.

The 8-hour ozone NAAQS allows for maximum ozone levels of 0.08 ppm concentration averaged over eight hours.[5]

The 2002 New Jersey Emissions Inventory indicates that VOC emissions were emitted from many sources, with no source contributing a majority of the emissions. In 2002, about 471,000 tons per year (tpy) of VOCs were emitted from New Jersey's point (stationary sources), area (small stationary sources, consumer products and paints) and mobile sources (cars, trucks, construction equipment and lawn mowers). Of these, 6% were from point sources, 27% were from area sources, 23% were from onroad sources, and 15% were from nonroad sources.

The 2002 New Jersey Emissions Inventory indicates that NOx emissions were emitted from combustion sources, with a significant portion of the NOx emissions from onroad mobile sources. In 2002, 353,000 tpy of NOx were emitted from point, area and mobile sources. Of these, 15% were from point sources, 8% from area sources, 58% from onroad sources and 19% from nonroad sources.

PARTICULATE MATTER

Fine particulate matter ($PM_{2.5}$), is a mixture of fine liquid and solid particles such as dust, smoke, mist, fumes or soot that pollutes the air and causes serious health problems. These particles are often so tiny that several thousand could fit on the period at the end of this sentence. PM2.5 consists of particles with a diameter of less than 2.5 microns. The fine particulate problem in New Jersey comes from sources such as diesel-powered engines that directly emit particles and from upwind power plants that emit both direct fine particles and gases that are converted to particles as they travel downwind to New Jersey. A major contributor of particulates from in-state sources is diesel exhaust from on-road vehicles.[6] In addition, wood smoke is major contributor of particulates. [7]

The USEPA has designated two nonattainment areas for $PM_{2.5}$ in New Jersey, the New York-New Jersey-Long Island-Connecticut Nonattainment Area and the Pennsylvania-New Jersey-Delaware Nonattainment Area. Four counties within the Highlands Region, Bergen, Passaic, Morris, and Somerset are designated nonattainment for $PM_{2.5}$ because of their predicted significant impacts on nonattainment monitoring in the New York-New Jersey-Long Island-Connecticut Nonattainment Area. The remaining counties in the Highlands Region, Sussex, Warren, and Hunterdon are in attainment for $PM_{2.5}$. The nonattainment area was designated for the $PM_{2.5}$ NAAQS annual standard of 15.0 micrograms per cubic meter.[8]

The New Jersey 2002 Emissions Inventory indicates that area sources are a significant source of $PM_{2.5}$.

[4] http://www.state.nj.us/dep/ipoca/ozone.htm

[5] http://www.epa.gov/ttn/naaqs/

[6] http://www.state.nj.us/dep/ipoca/finepart.htm

[7] http://www.nj.gov/dep/airworkgroups/docs/emissions_inventory_presentation.pdf

[8] http://epa.gov/air/criteria.html

In the 2002 inventory, it is estimated that about 30,000 tpy of $PM_{2.5}$ were from point, area, and mobile sources. Of these sources, 16% were from point sources, 54% from area sources, 11% from onroad sources, and 19% from nonroad sources.

SULFUR DIOXIDE

SO_2 gases are formed when fuel containing sulfur (mainly coal and oil) is burned. Metal smelting and other industrial processes can also emit SO_2. The highest monitored concentrations of SO_2 have been recorded in the vicinity of large industrial facilities. Fuel combustion, largely from electricity generation, accounts for most of the total SO_2 emissions.[9] SO_2 emissions from upwind power plants can be transformed into particulate matter and accounts for about half of the fine particulates in New Jersey's air.[10]

The USEPA has designated a portion of Warren County as nonattainment for SO_2. The SO_2 nonattainment area in Warren County consists of Belvidere Town, Harmony Township, Oxford Township, White Township, portions of Liberty Township and portions of Mansfield Township. The remaining municipalities in Warren County and the remainder of the municipalities throughout the Highlands Region are in attainment for SO_2.

The SO_2 NAAQS includes an annual standard and a 24-hour standard. The annual standard is averaged over a three-year period and can not exceed 0.03 parts per million (ppm) (80 micrograms per cubic meter). The 24-hour standard of 0.14 ppm (365 micrograms per cubic meter) is not to be exceeded more than once per year.[11]

The New Jersey 2002 Emissions Inventory indicates that point sources are the significant source of SO_2. In the 2002 inventory, it is estimated that about 95,000 tpy of SO_2 were emitted from point, area and mobile sources. Of these sources, 65% were from point sources, 11% from area sources, 6% from onroad sources and 18% from nonroad sources.

AIR TOXICS

Any other air pollutants that are not criteria pollutants, and that may be emitted into the air in quantities that can cause adverse health effects, can be classified as air toxics. These health effects cover a wide range of conditions from lung irritation to birth defects to cancer. There are no national air quality standards (NAAQS) for these pollutants, but the 1990 Clean Air Act Amendments listed almost 200 of these air toxics (or "hazardous air pollutants" or "HAPs") and directed the USEPA to develop control technology standards for sources which emitted them. There is some overlap in the grouping of pollutants. Particulate matter can contain air toxics particles, and lead is both on the HAP list and a criteria pollutant. Many of the volatile organic compounds that contribute to the formation of ozone are also HAPs.

Air toxics come from a wide variety of sources, including traditional industrial and utility sources, smaller manufacturing and commercial sources, on-road mobile sources (such as cars, trucks and buses), residential activities (such as oil burning for home heating, and painting houses), and non-road mobile sources such as construction equipment.

[9] http://www.epa.gov/air/airtrends/sulfur.html

[10] http://www.state.nj.us/dep/ipoca/finepart_fed.htm

[11] http://www.epa.gov/air/airtrends/sulfur2.html

REGIONAL HAZE

Haze is caused when sunlight encounters tiny pollution particles in the air. Some light is absorbed by particles while other light is scattered away before it reaches an observer. More pollutants mean more absorption and scattering of light, which reduces the clarity and color of what we see. Some types of particles such as sulfates, scatter more light, particularly during humid conditions.[12]

Air pollutants come from a variety of natural and manmade sources. Natural sources include windblown dust and soot from wildfires. Manmade sources include fireplaces, motor vehicles, electric utility and industrial fuel burning, and manufacturing operations. Particulate matter pollution is the major cause of reduced visibility (haze) in parts of the United States, including many of our national parks.[13]

The federal CAA contains requirements for states to protect and improve visibility in national parks and wilderness areas. In 1977, Congress designated certain national parks and wilderness areas as "Class 1 areas," where visibility was identified as an important value. The Brigantine Wilderness Area of the Edwin B. Forsythe National Wildlife Refuge in southern New Jersey is the only Class 1 area in the Mid-Atlantic Region. This wilderness area is important, not only in the intrinsic value as a marsh and tidal area, but is also important as a stopover point for migratory birds. The visibility protection provisions of the 1990 CAA provide the same visibility protection for the Brigantine Wilderness Area as for the Grand Canyon. The visibility improvement plan for Brigantine may help address visibility in the entire Mid-Atlantic States region, including the Highlands Region.

POLLUTION IN THE HIGHLANDS REGION

This section provides more detailed evaluation of the NO_x, VOC, $PM_{2.5}$ and SO_2 emissions from the New Jersey 2002 Emissions Inventory for the Highlands Region. The data for the relevant counties were extracted from the inventory and scaled to represent the Highlands Region using population data and vehicle miles traveled data. Therefore, the emissions from Morris County are generally higher than the other counties within the Highlands Region because the Highlands portion of the Morris County contains densely populated areas; in addition, a large portion of Morris County is within the Highlands Region which is not the case for some of the other counties in the Highlands Region. Figures 1 - 4 provide a representation of the analysis by sources and county.

In all counties, the onroad sources contributed the greatest amount of NO_x emissions in the region.

In Hunterdon, Morris, Passaic, Sussex, and Warren counties, area sources contributed the greatest amount of VOC emissions in the region. In Bergen and Somerset counties, onroad sources contributed the greatest amount of VOCs in the region.

In all counties, the area sources contributed the greatest amount of $PM_{2.5}$ emissions in the region.

The SO_2 nonattainment problem is associated with emissions from two power plants located in Pennsylvania. For further discussion, see the section on Emissions from Power Plants.

[12] http://www.epa.gov/oar/visibility/what.html

[13] http://www.epa.gov/oar/visibility/what.html

Figure 1: NO_x Emissions in the Highlands Region by Source and County

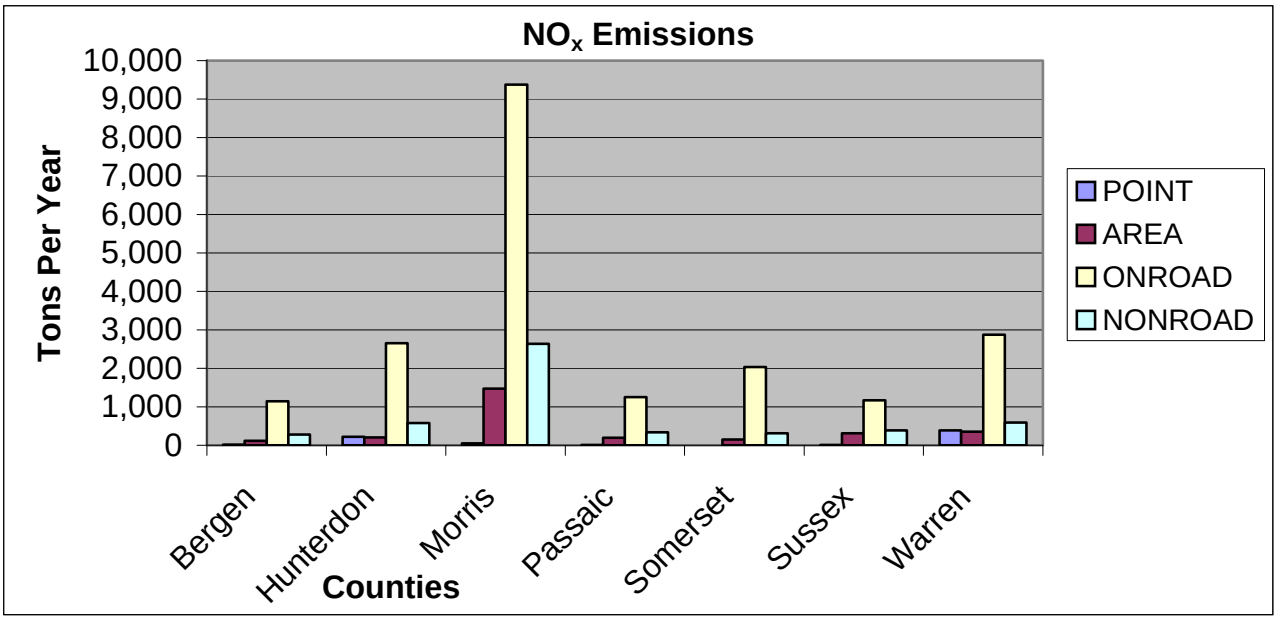


Figure 2: VOC Emissions in the Highlands Region by Source and County

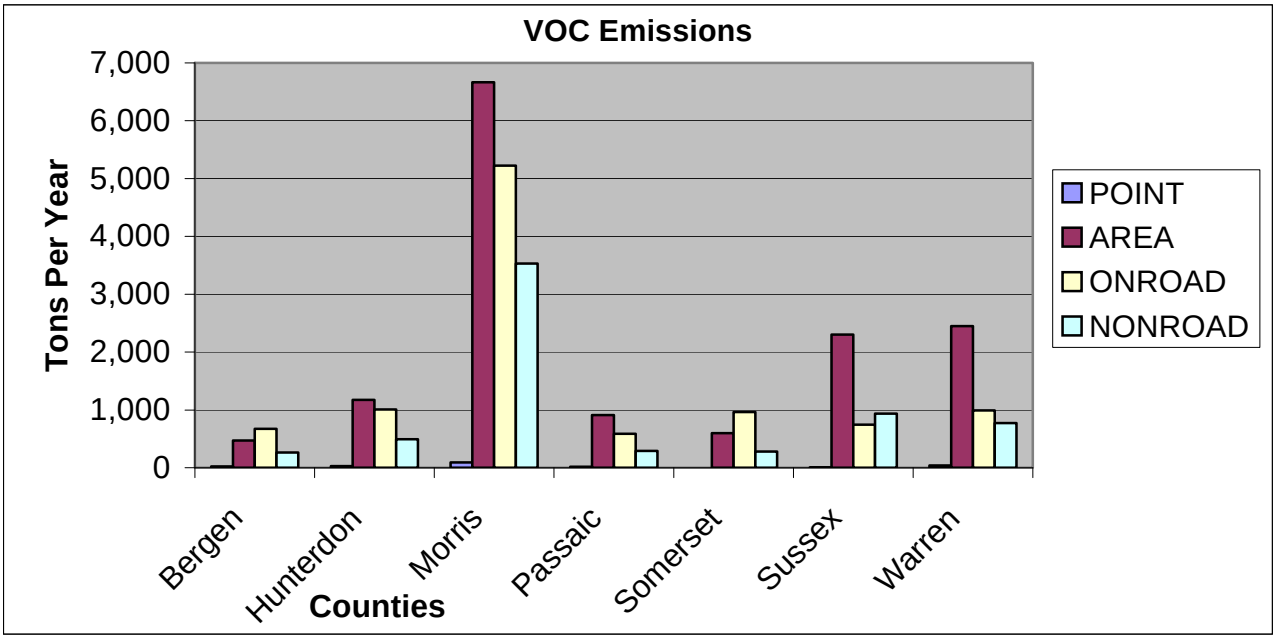


Figure 3: $PM_{2.5}$ Emissions in the Highlands Region by Source and County

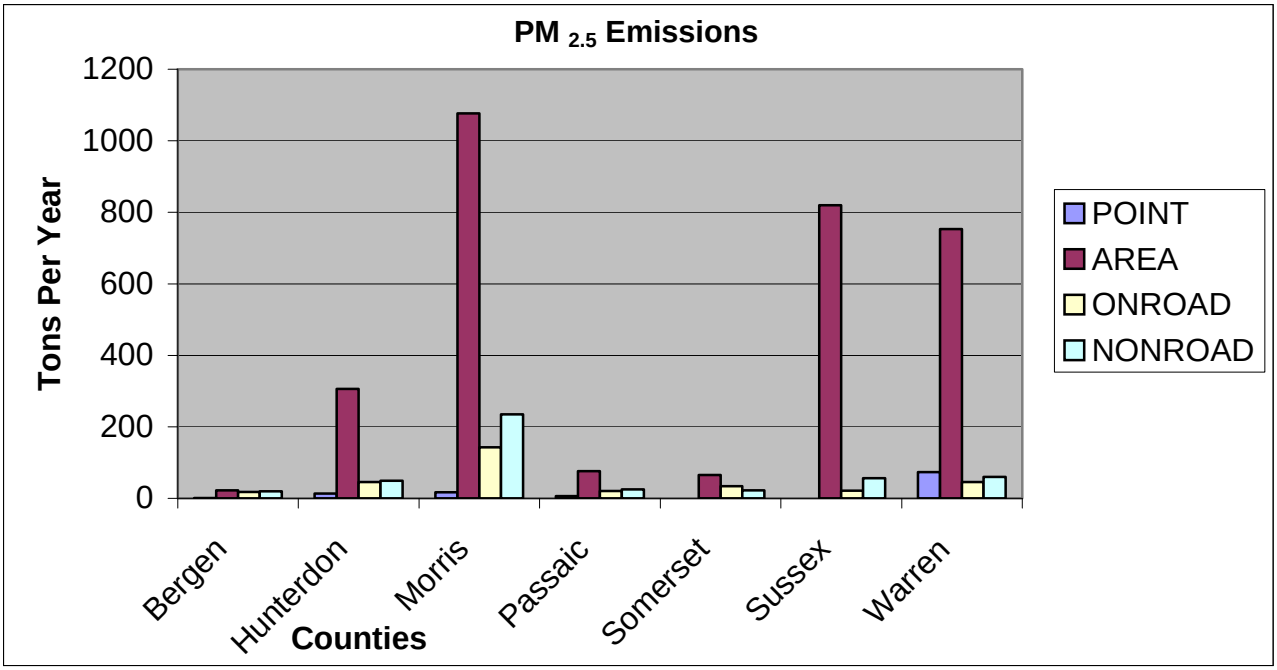
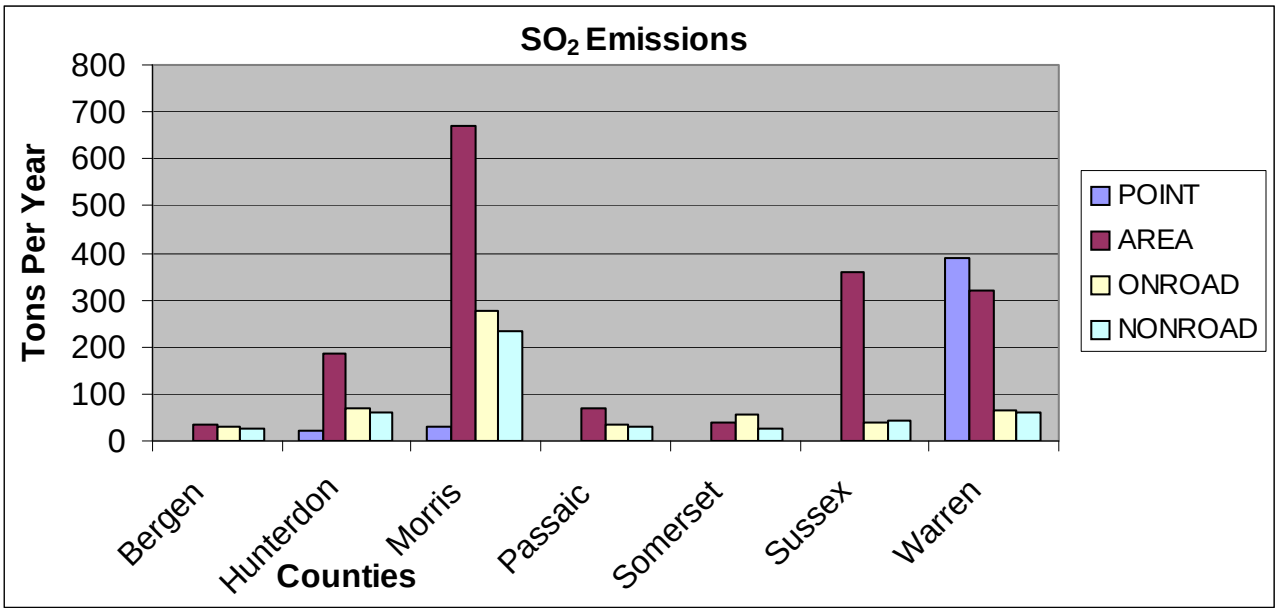


Figure 4: SO_2 Emissions in the Highlands Region By Source and County



POINT SOURCES

The five largest point sources in the Highlands Region are Gilbert Generating Station; Hunterdon Cogeneration, Limited Partnership; Warren County District Landfill; DSM Nutritional Products, Inc.; and Covanta Warren Energy Resource Company, LP. Gilbert Generating Station and Hunterdon

Cogeneration are located in Hunterdon County, and the remaining facilities are located in Warren County. Table 1 includes the NO_x, VOC, $PM_{2.5}$ and SO_2 emissions from 2004 for the five facilities reported in tons per year (tpy).[14] This information was obtained from New Jersey's Emissions Statement Program.[15]

TABLE 1: EMISSIONS FROM FIVE OF THE MAJOR POINT SOURCES IN THE HIGHLANDS REGION

Facility Name	NO_x (tpy)	$PM_{2.5}$ (tpy)	SO_2 (tpy)	VOC (tpy)
Gilbert Generating Station	88.5	4.37	10.4	1.45
Warren County District Landfill	8.36	3.99	369.4	1.34
DSM Nutritional Products	78.0	46.4	6.61	20.9
Hunterdon Cogeneration	35.0	1.57	6.32	.340
Covanta Warren Energy Resources	242	3.76	3.31	.370

Source: NJDEP Emissions Statement Program, August 2006

EMISSIONS FROM POWER PLANTS

The Gilbert Generating Station, Hunterdon Cogeneration and Covanta Warren Energy Resource Company are oil and gas electric generating facilities. These facilities emit NO_x and SO_2 emissions as a result of the combustion process. While the emissions of air pollutants from electric generation is of concern because of their potential to form acid rain, ozone and fine particles throughout the State, electric generation in the Highlands Region itself is not a major contributor to the NAAQS exceedances within New Jersey.

Power plants located outside the state have a greater impact on air quality in the Highlands Region and in New Jersey. A significant amount of New Jersey's ozone results from NO_x emitted by power plant and industrial facilities upwind of the state. The wind can transport this pollution hundreds of miles.[16]

One such source is the Martins Creek power plant, which is located in Northampton County, Pennsylvania. In May 2003, New Jersey announced a landmark agreement with Pennsylvania Power and Light Generation, LLC (PPL), to shut down the two coal-fired units and to take other actions to significantly reduce emissions of air pollutants from the plant. The final agreement will lead to an 80 percent reduction or more than 20,000 tons per year by 2007, of the plant's sulfur dioxide emissions. The agreement will also lead to reductions of NO_x, mercury, and fine particulate emissions. The agreement marked the first time that a state was able to negotiate the shutdown of a coal-fired power plant outside its borders and was an essential complement to New Jersey's efforts to set more protective emission requirements for facilities inside the state.[17] The remaining two oil-fired units are used primarily for peak power demand and contribute significant NO_x emissions on high ozone days.

[14] http://www.nj.gov/dep/opra/online.html
[15] http://www.state.nj.us/dep/aqm/es/emission.htm
[16] http://www.state.nj.us/dep/ipoca/nonattain.htm
[17] http://www.nj.gov/dep/cleanair/hilite_clean_air.pdf

Another nearby source of concern is Reliant Energy's Portland Power Plant. Located in Pennsylvania on the Delaware River across from New Jersey near the Delaware Water Gap, the facility consists of two coal-fired electric generating units that emit approximately 30,000 tons per year of sulfur dioxide. The NJDEP recently submitted a petition to the USEPA Region III requesting they object to renewal of the facility's Title V operating permit. The objections raised include the failure of the proposed permit to address past violations of New Source Review (NSR) and New Source Performance Standards (NSPS), and the removal of maximum heat input limitations contained in previous permits. In December of 2007 the NJDEP filed a federal lawsuit against Reliant Energy for not implementing NSR and NSPS standards at the Portland facility.

WARREN COUNTY DISTRICT LANDFILL

In the past, Warren County District Landfill (WCDL) at Oxford Township accepted construction demolition debris. Hydrogen sulfide (H_2S) was released from the degradation of gypsum contained in the construction debris, specifically wallboards, which resulted in unhealthy contaminant air emissions. The WCDL has recently consented to install a system to desulfurize the collected landfill gas. The treated landfill gas will be delivered to the adjoining DCO Energy facility for combustion in engines which produce electricity. Recently, the Air Pollution Control Permit (APC) for this Landfill Gas to Energy Generation Project at the Warren County Landfill was issued. Upon project start up, 1.9 Megawatts (MW) of power will be produced from landfill gas treated by the Pollution Control Financing Authority. The power project will yield two major environment benefits: 1) the control of methane (a potent greenhouse gas) and 2) the generation of electric power that potentially displaces the air contaminants that would have otherwise been generated at a power plant. The electricity generated by the engines will be equivalent to that used by approximately 4,000 homes. In addition, the two engines will reduce methane emissions by 15,600 tons per year. The scrubber project will reduce H_2S air emissions by 400 tons per year.

The NJDEP filed an enforcement action against the facility due to violations for failure to obtain Preconstruction Permits and Operating Permits for the landfill vents.

AIR QUALITY TRENDS IN THE HIGHLANDS REGION

NJDEP currently operates four permanent air-monitoring sites in the Highlands Region (Figure 5). The parameters monitored at each site are shown in Table 2 below.

Figure 5

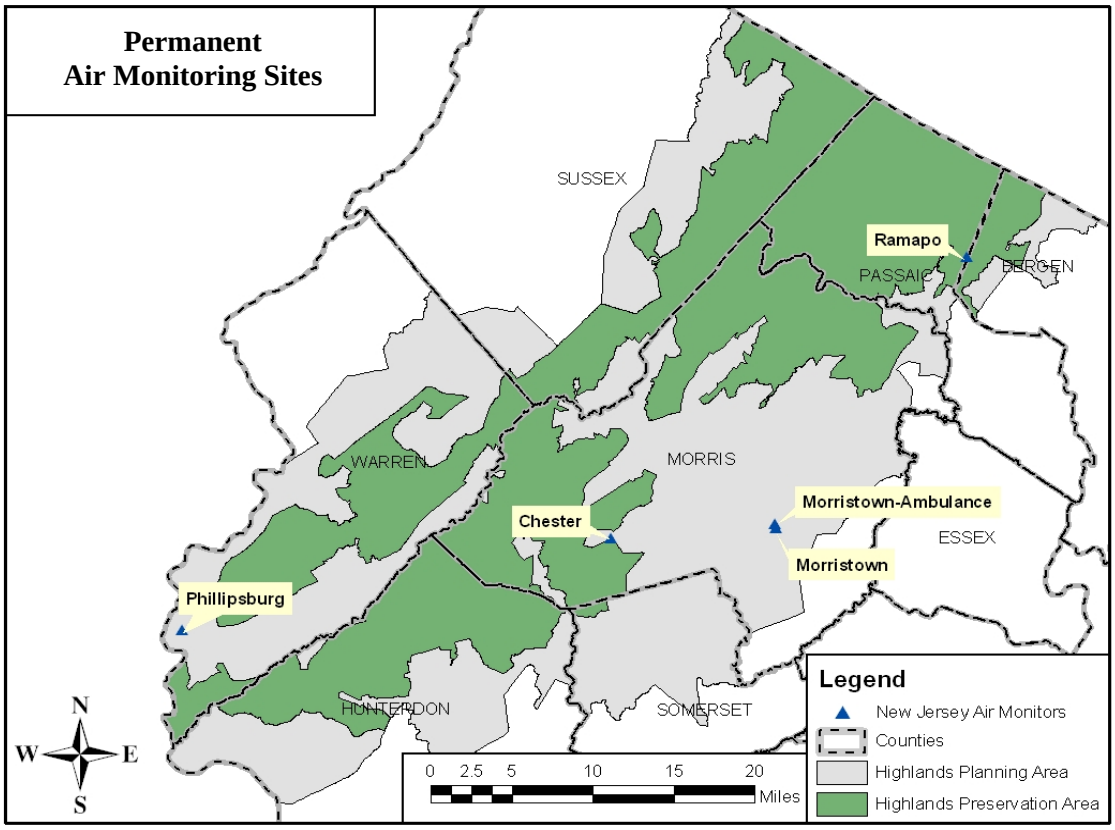


TABLE 2: HIGHLANDS PLANNING AND PRESERVATION AIR MONITORING SITES	
LOCATION	**POLLUTANTS MONITORED**
Chester	Ozone, NO_x, $PM_{2.5}$ (including composition analysis), Toxics
Phillipsburg	$PM_{2.5}$
Morristown (11 Washington Street)	CO, Smoke Shade (Particulates)
Morristown (Ambulance Squad, 16 Early Street)	PM $_{2.5}$
Ramapo	Ozone

Source: NJDEP Air Monitoring Program, August 2006

In addition to the permanent state operated sites, a special three-year air monitoring study was conducted in Warren County, primarily to address potentially high short term exposures to SO_2. The area in Warren County where the monitoring study was conducted is the only area of the state that is designated as a non-attainment area for SO_2. Three sites were established as part of that study, and additional monitoring was included as a result of public meetings held in the area prior to the initiation of the study. The locations of the sites are shown in Figure 6 and the parameters measured at each are shown in Table 3 below.

Figure 6

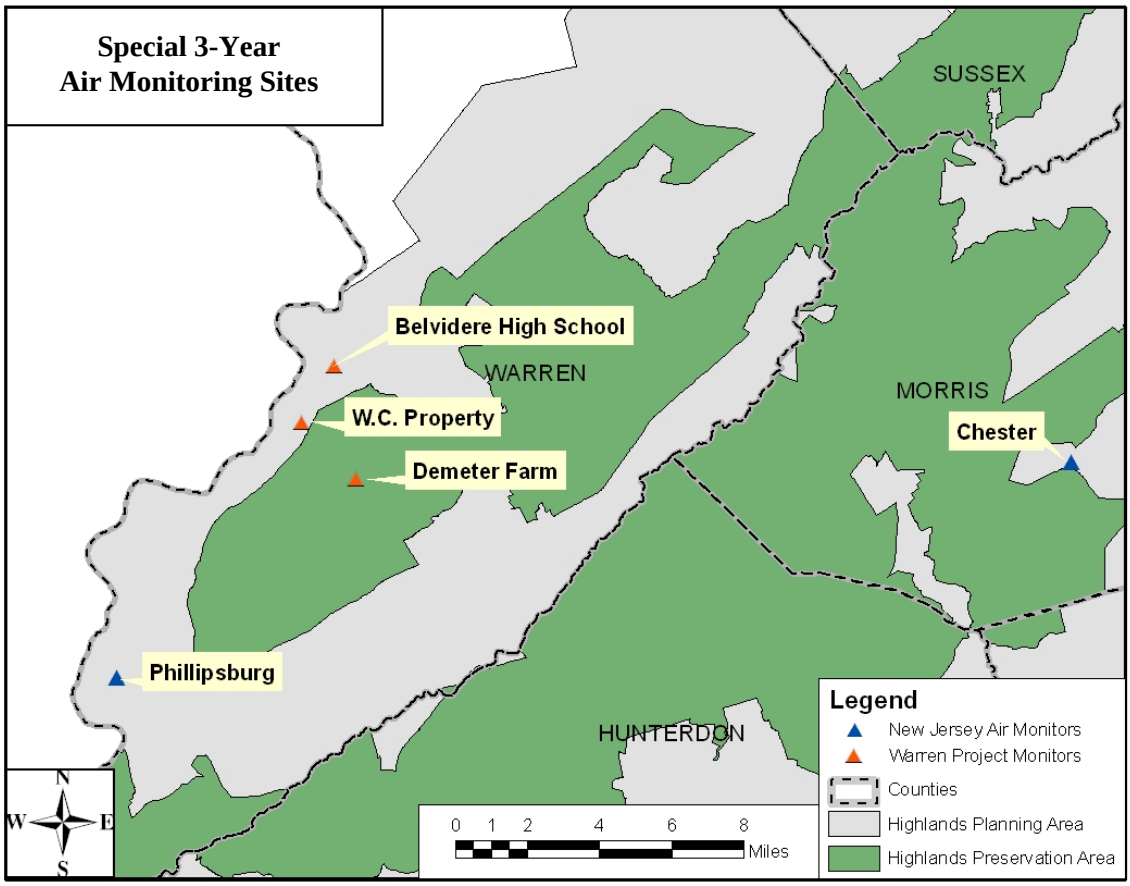


TABLE 3: WARREN COUNTY SPECIAL STUDY SITES	
LOCATION	**POLLUTANTS MONITORED**
Belvidere High School	SO_2, $PM_{2.5}$, Toxics, Mercury (in precipitation), Meteorology
County Complex	SO_2
Demeter Farm	SO_2

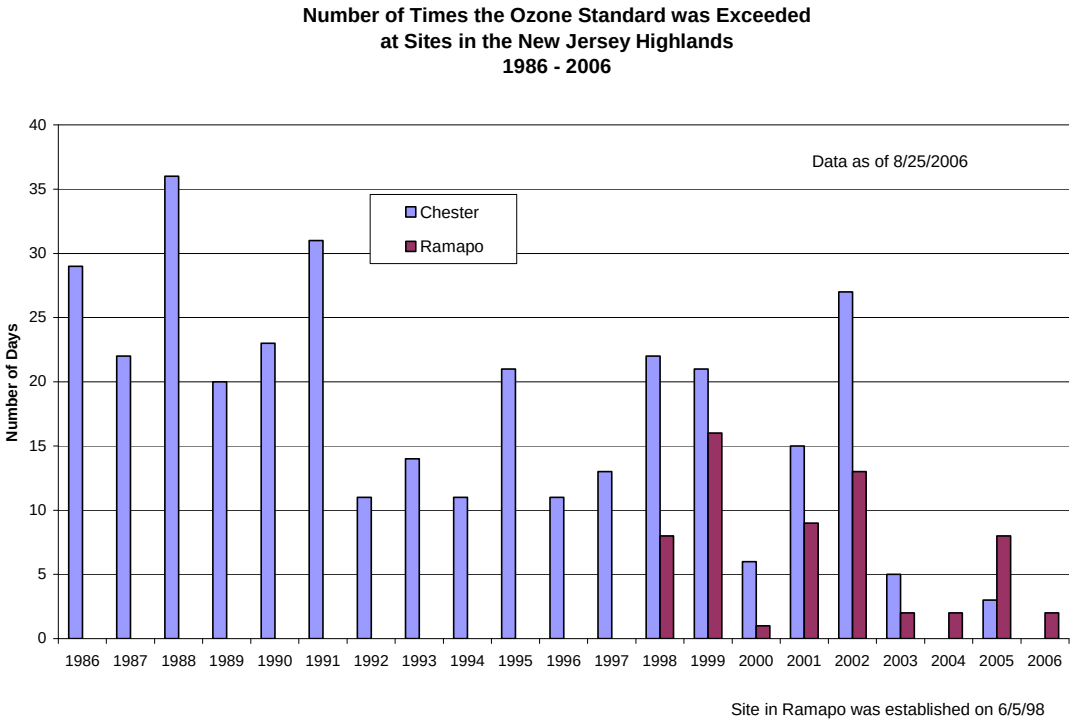
Source: NJDEP Air Monitoring Program, August 2006

METEOROLOGY

In general, the air monitoring conducted in the Highlands Region shows lower levels of pollution than are recorded in more urbanized parts of the state. However, there are still air quality issues in this area. Some of these, such as ozone and fine particle pollution, are primarily the result of pollution that is transported into the area on prevailing winds, and much of it originates out of state. Other problems are related to specific sources, some in New Jersey and some in other states as well. Like all of the ozone monitoring sites in New Jersey, the sites in Chester and Ramapo regularly record exceedances of the health standard for ozone during the summer months. The number of days in excess of the ozone standard recorded at these sites is shown in Figure 7 below. Note that the Ramapo site was not established until 1998. More detailed information on historical ozone levels at all the New Jersey

monitoring sties can be found on the NJDEP web site at www.state.nj.us/dep/airmon.

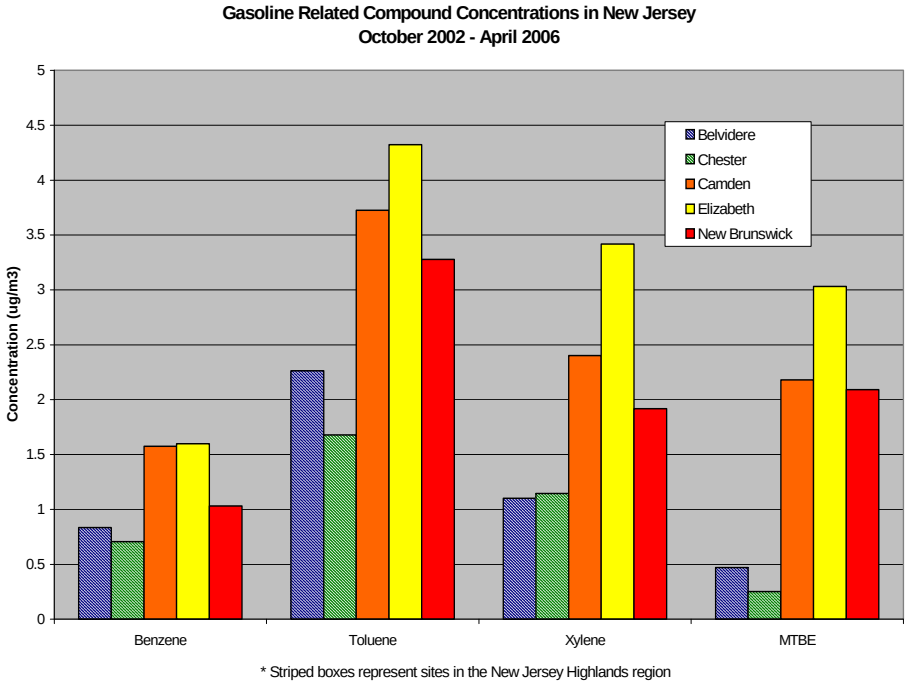
Figure 7



Another pollutant of concern in most of New Jersey is $PM_{2.5}$. The state monitors for $PM_{2.5}$ at two sites in the Highlands Region, Phillipsburg and Morristown. While levels of $PM_{2.5}$ at these sites are not as high as at some other sites in more urbanized areas, they do record levels considered to be "unhealthy for sensitive groups" (USG) several times a year. The USG levels have been established by the USEPA as part of their Air Quality Index rating system. When concentrations reach this level, persons who are sensitive to $PM_{2.5}$ may experience adverse health effects. Sensitive individuals include those with existing heart or lung problems, the elderly, and young children.

Air toxics are also measured in the Highlands Region. The state operated site in Chester and one of the special study sites in Warren County measured a number of common VOCs. Levels of some of the more common compounds, those primarily associated with gasoline, are shown in the graph in Figure 8. Again, the lower concentrations of air toxics reflect the less urbanized nature of the areas around the monitoring sites. High levels of air toxics that might occur as the result of emissions from specific industrial sources would be controlled through the NJDEP's air pollution permitting program. This program requires an assessment of air toxics emissions from potentially significant sources.

Figure 8



As parts of Warren County have been designated as a non-attainment area for SO_2, additional monitoring for SO_2 was conducted through an agreement with some of the sources in the area. Originally proposed as a Supplemental Environmental Project to be funded as part of an enforcement settlement with the NJDEP, the monitoring project was expanded to include $PM_{2.5}$, air toxics, and mercury. Additional funding for the project was contributed by other sources in the region, and NJDEP provided technical oversight. The complete data set for this project is available at www.airqap.com and, as the project also included monitoring in Pennsylvania, it is known as the Warren-Northampton Regional Air Quality Monitoring Program. During the three years of the study, no violations of the NAAQS for SO_2 were recorded. But the primary purpose of the study was to monitor potentially high short-term (5-minute average) concentrations based on a USEPA proposal to establish a 5-minute average guideline for SO_2. Some health studies have shown that exposure to high concentrations of SO_2 for even short durations can trigger asthma attacks in sensitive individuals. During the course of the three-year study, the USEPA proposed guideline concentration was never exceeded at the two monitoring sites located in the community. A monitoring site established at higher elevation (Demeter Farm Site), expected to be most directly impacted by nearby power plants did record levels above the guideline on five days during the three-year study. The area surrounding that site is very sparsely populated.

At one time, the monitoring site in Morristown regularly recorded exceedances of the NAAQS for CO. This was common for most cities in New Jersey prior to the introduction of catalytic converters and other pollution control devices on automobiles. These controls have been so effective that there has not been an excess of the CO standard anywhere in New Jersey since 1995. The last exceedance at the Morristown site occurred on November 26, 1986.

THE ENVIRONMENT AND HUMAN HEALTH EFFECTS

ENVIRONMENTAL IMPACTS FROM OZONE

Ground-level ozone interferes with the ability of plants to produce and store food, which makes them more susceptible to disease, insects, other pollutants, and harsh weather. Ozone damages the leaves of trees and other plants, ruining the appearance of cities, national parks, and recreation areas. Ozone reduces crop and forest yields and increases plant vulnerability to disease, pests, and harsh weather.[18]

HEALTH IMPACTS FROM OZONE

Ground-level ozone is formed when NO_x and VOCs react in the presence of sunlight. Children, people with lung diseases such as asthma, and people who work or exercise outside are susceptible to adverse effects such as damage to lung tissue and reduction in lung function.[19]

Ozone can irritate lung airways and cause inflammation much like sunburn. Other symptoms include wheezing, coughing, pain when taking a deep breath and breathing difficulties during exercise or outdoor activities.

Repeated exposure to ozone pollution for several months may cause permanent lung damage. Anyone who spends time outdoors in the summer when ozone levels are high is at risk, particularly children and other people who are active outdoors.

Even at very low levels, ground-level ozone triggers a variety of health problems including aggravated asthma, reduced lung capacity, and increased susceptibility to respiratory illnesses like pneumonia and bronchitis.[20]

Attaining the new federal health standard for ozone in New Jersey would eliminate about 40,000 asthma attacks each year and substantially reduce hospital admissions and emergency room visits among children and adults with asthma and other respiratory diseases.[21]

ENVIRONMENTAL IMPACTS FROM FINE PARTICULATES ($PM_{2.5}$)

Fine particles are the major cause of reduced visibility in parts of the United States, including many of our treasured national parks and wilderness areas. Particles can be carried over long distances by wind and then settle on the ground or in the water. The effects of this settling include: making lakes and streams acidic; changing the nutrient balance in coastal waters and large river basins; depleting the nutrients in soil; damaging sensitive forests and farm crops; and affecting the diversity of ecosystems. Particle pollution can stain and damage stone and other materials, including culturally important objects such as statues and monuments.[22]

HEALTH IMPACTS FROM FINE PARTICULATES ($PM_{2.5}$)

The size of particles is directly linked to their potential for causing health problems. Small particles pose the greatest health problems, because they can lodge deep in your lungs and some may even get into

[18] http://www.epa.gov/air/urbanair/ozone/hlth.html
[19] http://www.epa.gov/air/urbanair/nox/hlth.html
[20] http://www.epa.gov/air/urbanair/ozone/hlth.html
[21] http://www.state.nj.us/dep/ipoca/ozone.htm
[22] http://www.epa.gov/oar/particlepollution/health.html

your bloodstream.[23]

Exposure to such particles can affect both your lungs and your heart. Small particles of concern include coarse particles (such as those found near roadways and dusty industries), which have diameters between 2.5 and 10 micrometers; and "fine particles" (found in smoke and haze), which are 2.5 micrometers in diameter or less.[24]

Health studies have shown a significant association between exposure to fine particles and premature death. Other important health effects include aggravation of respiratory and cardiovascular disease (as indicated by increased hospital admissions, emergency room visits, absences from school or work, and restricted activity days), lung disease, decreased lung function, asthma attacks, and certain cardiovascular problems, such as heart attacks and irregular heart beat. Individuals particularly sensitive to fine particle exposure include older adults, people with heart and lung disease, and children.[25]

NJDEP estimates that in New Jersey every year, exposure to fine particulate levels above the federal health standard results in an estimated 1,900 deaths and 53,000 asthma attacks. This death rate is nearly twice that from motor vehicle accidents (approximately 730 annually in New Jersey) and homicides (approximately 300 annually).

ENVIRONMENTAL IMPACTS FROM SO_2

There are a variety of environmental concerns associated with high concentrations of SO_2. Because SO_2, along with NO_x, is a major precursor to acidic deposition (acid rain), it contributes to the acidification of soils, lakes, and streams and the associated adverse impacts on ecosystems. Sulfur dioxide exposure to vegetation can increase foliar injury, decrease plant growth and yield, and decrease the number and variety of plant species in a given community. Sulfur dioxide also is a major precursor to $PM_{2.5}$ (aerosols), which is of significant concern to human health, as well as visibility impairment. SO_2 can also accelerate the corrosion of natural and man-made materials (e.g., concrete and limestone) that are used in buildings and monuments, as well as paper, iron-containing metals, zinc, and other protective coatings. [26]

Recently, the results from an epidemiologic asthma study conducted in the Belvidere/White Township area in Warren County, NJ, were released. The study involved an examination of the association between asthma exacerbation and air pollution among adolescents with physician-diagnosed asthma. Sixty-four students were initially recruited in 2003 for the study. The students were asked to self-report asthma symptoms/severity, peak flow rate and medication use through a web-based questionnaire. Environmental conditions were monitored during the study period. Results from this study indicate that there was a statistically significant inverse association between peak flow rate and sulfur dioxide concentration even when the sulfur dioxide concentration did not exceed national health-based standards. No association was found for pollen, particulate matter, or volatile organic compound concentrations.

HEALTH IMPACTS FROM SO_2

High concentrations of SO_2 can result in temporary breathing impairment for asthmatic children and adults who are active outdoors. Short-term exposures of asthmatic individuals to elevated SO_2 levels

[23] http://www.epa.gov/air/urbanair/nox/hlth.html
[24] http://www.epa.gov/oar/particlepollution/health.html
[25] http://www.epa.gov/pmdesignations/faq.htm#2
[26] http://www.epa.gov/air/airtrends/sulfur2.html

while at moderate exertion may result in reduced lung function that may be accompanied by symptoms such as wheezing, chest tightness, or shortness of breath. Other effects that have been associated with longer-term exposures to high concentrations of SO_2, in conjunction with high levels of PM, include respiratory illness, alterations in the lungs' defenses, and aggravation of existing cardiovascular disease. The subgroups of the population that may be affected under these conditions include individuals with cardiovascular disease or chronic lung disease, as well as children and the elderly.[27]

ACID DEPOSITION AND ITS EFFECT ON THE HIGHLANDS REGION

Acidic deposition, also termed acid rain, has a number of effects on ecosystems. These effects include a gradual erosion of the buffering capacity of soils and an associated loss of soil fertility. Effects also include loss of vitality and biodiversity in terrestrial and aquatic systems and higher concentrations of heavy metals in fish and waters.

In precipitation, most acidity is contributed by sulfuric acid (H_2SO_4) and nitric acid (HNO_3). Deposition of associated nutrients, especially nitrate (NO_3) and sulfate (SO_4), also has important impacts on the environment. Nitrate deposition can damage terrestrial ecosystems by harming beneficial fungi and encouraging the growth of invasive species. Sulfate can combine with calcium and other essential plant nutrients, causing them to leach more quickly from the soil and thus lowering soil fertility.

In much of the eastern United States, due to anthropogenic emissions of SO_2 and NO_x, the concentrations of sulfuric and nitric acids in precipitation are so high that the pH of rain is often in the 3.5 to 5.0 range.[28] This is approximately 10 times more acidic than unpolluted rain. Some fogs have been measured with pH readings as low as 2.0, which is highly acidic.[29]

Acid precipitation has damaged wildlife and ecosystems in many parts of the United States and Europe. Regions where the soils and water bodies have limited buffering capacity to neutralize the deposited acids, including parts of the Highlands Region, have been affected the most. The buffering capacity of most soils is sufficient to neutralize naturally occurring acids, but over time the capacity can be overwhelmed by high inputs of acid deposition. A dramatic effect of the acidification of some water bodies is loss of fish species, which has happened in some areas. In studies of several lakes in New Jersey, it was found that low pH is also associated with higher concentrations of mercury, cadmium, and lead in fish,[30] and that lower pH is associated as well with higher levels of aluminum, lead, and zinc in the water column of acidic lakes.[31]

Ecosystem effects of acid rain are widespread. Studies at Hubbard Brook Experimental Forest in New Hampshire have revealed that concentrations of the nutrients calcium and magnesium (which neutralize acidity, but are leached from soils in the process) have been lowered and vegetative growth has slowed as

[27] http://www.epa.gov/air/airtrends/sulfur2.html

[28] The pH is the antilog of the concentration of hydrogen ions, H^+, in moles per liter. Thus a sample with a pH of 5.0 has 1 x 10^{-5} moles of H^+ per liter. Rainfall, unless buffered by cations in airborne particles, tends to be naturally acidic, with a pH in the range of 5.6. This is due to the presence in the air of carbon dioxide, which dissolves in water producing carbonic acid.

[29] Spiro, Thomas, and William Stigliani, 2003, *Chemistry of the Environment, 2nd Edition*, Prentice Hall, Upper Saddle River, NJ 07458, page 279.

[30] Sprenger, Mark, Alan McIntosh, and Stephanie Hoenig, 1988, Concentrations of Trace Elements in Yellow Perch (*Perca flavescens*) from Six Acidic Lakes, *Water, Air, and Soil Pollution, 37*, 375-388.

[31] Sprenger, Mark, A. McIntosh, and T. Lewis, 1987, Variability in Concentrations of Selected Trace Elements in Water and Sediment of Six Acidic Lakes, *Arch. Environ. Contam. Toxicol. 16*, 383-390.

a result of decades of acidic precipitation. Studies at other sites in the Northeast also show reductions in nutrient levels, as well as the release of aluminum, which can block nutrient uptake by vegetation. Acid fogs and rains also have been found to leach calcium directly from spruce needles, damaging the trees. [32]It is likely that effects such as these have occurred and continue to occur in the Highlands Region. More monitoring of specific water bodies and terrestrial ecosystems in the region could help clarify the extent of the impacts.

Long term data on acid deposition in New Jersey and Northeastern Pennsylvania show evidence of modest improvement. Since the early 1980s, there has been a decline in deposition of sulfate and nutrient cations and a significant increase in pH. Yet the average pH of precipitation remains in the range of 4.5, which is much more acidic than expected for unpolluted rain in the Northeast. The improvement is due to rules that are in place at both federal and state level to reduce emissions of SO_2 and NO_x, from sources primarily coal-fired power plants.[33] Some of these rules have been in effect for more than two decades and have reduced United States emissions of SO_2 by about 40 percent.[34] [35] Studies have shown a virtually universal reduction in deposition of sulfates because of a decrease in SO_2 emissions, but there has not been a decrease in overall acidity in many regions.[36]

Despite a general decline in acid deposition in both Europe and North America, some areas show significant delay in aquatic recovery from acidification, and minimal biological recovery in waters or soils.[37] This delay probably is due to a depletion of neutralizing substances in soils and water bodies due to years of impact from acidic deposition. New, more stringent controls on SO_2 and NO_x emissions recently have been implemented at the federal level and in New Jersey, and these reductions are expected to have a positive impact on both acidic deposition and nitrate deposition. Whether these additional reductions will be sufficient to offset long-term impacts on ecosystems still is unclear. In some affected areas, it is estimated that an additional 80 percent reduction in emissions of SO_2 and NO_x will be required to permit soils to regenerate the base cation levels needed for healthy trees.[38]

HEALTH IMPACTS FROM EMISSIONS OF AIR TOXICS

In addition to criteria pollutants, air toxics are also released in the Highlands Region. Data on point source releases of air toxics in 2004 was obtained from the Release and Pollution Prevention (RPPR) database.[39] There are 48 facilities in the Highlands Region that reported releases in 2004. Five of these facilities release more that 10,000 lbs./yr of air toxics (all chemicals combined). These five facilities account for 82% of the point source releases in the Highlands Region.

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[32] Spiro & Stigliani, 2003, p. 301.

[33] For relevant NJ rules, see http://www.state.nj.us/dep/aqm/rules.html#27. Also see the USEPA acid rain program web site at http://www.epa.gov/airmarkets/arp/.

[34] Spiro & Stigliani, 2003, p. 303.

[35] Rules are in place in Europe as well, although they are not based on a cap and trade program as in the U.S. The European rules have led to a similar, perhaps even relatively larger, reduction in emissions.

[36] Yoon, Carol K., 1999, Report on acid rain finds good news and bad news: sulfate levels drop, but acidity continues, *NY Times*, October 7, 1999.

[37] Alewell, C., B. Manderscheid, H. Meesenburg, and J. Bittersohl, 2000, Is acidification still an ecological threat, *Nature, 407*, 856-857.

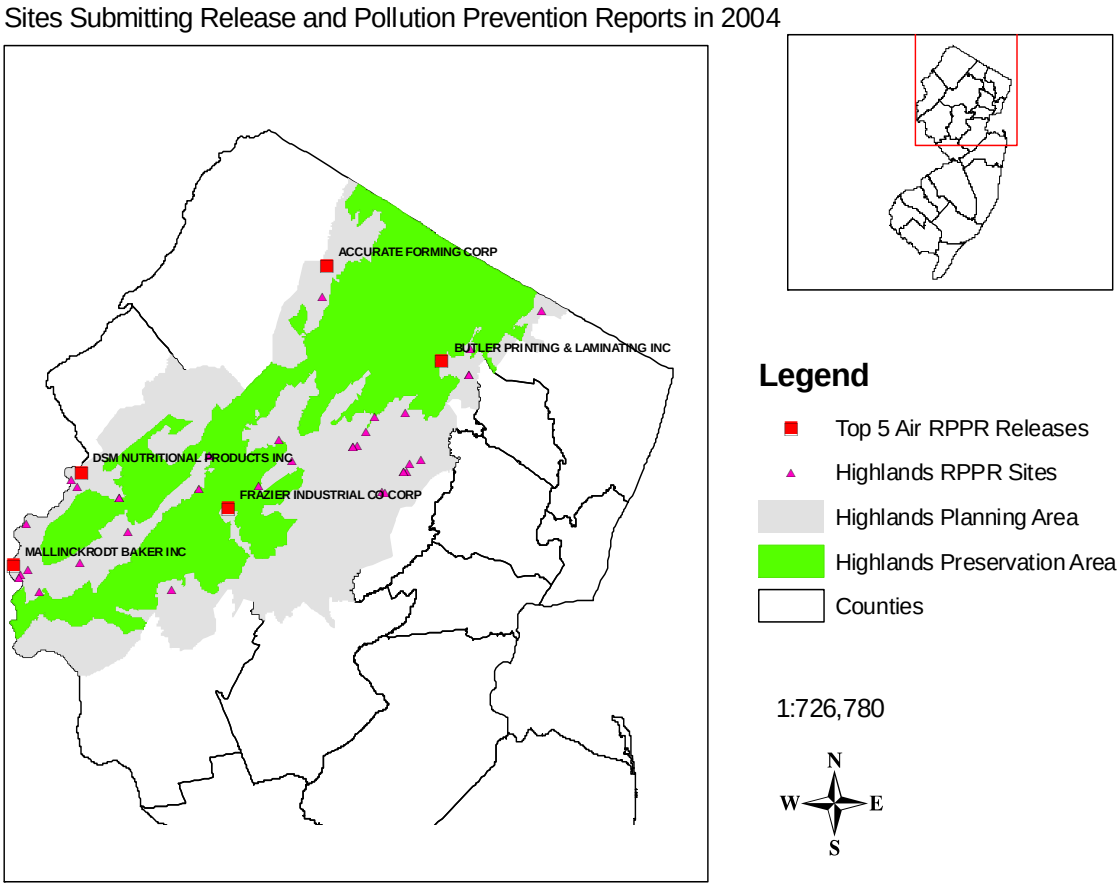
[38] Spiro & Stigliani, 2003, p. 303.

[39] http://www.nj.gov/dep/opppc/

Table 4: Emissions from Five Air Toxics Sources in the Highlands Region 2004 (lb/yr)				
SITE ID	SITE NAME	STACK AIR EMISSIONS	FUGITIVE AIR EMISSIONS	TOTAL AIR EMISSIONS
14557	MALLINCKRODT BAKER INC	55,203	15,181	70,384
1442	ACCURATE FORMING CORP	4,640	17,973	22,613
15798	DSM NUTRITIONAL PRODUCTS INC	17,500	4,317	21,817
3971	BUTLER PRINTING & LAMINATING INC	18,005	0	18,005
14776	FRAZIER INDUSTRIAL CO CORP	2,793	11,171	13,964

Source: RPPR database, 2006

Figure 9



HEALTH IMPACTS OF INDOOR AIR POLLUTION

A growing body of scientific evidence has indicated that the air within homes, schools and other buildings can be more seriously polluted than the outdoor air in even the largest and most industrialized cities. Research also indicates that people spend approximately 90% of their time indoors[40]. Thus, for many people, the risks to health may be greater due to exposure to air pollution indoors than outdoors. People who may be exposed to air pollutants for the greatest period of time are often those most susceptible to the health effects of indoor air pollution. For example, such groups include the young, the elderly, and the chronically ill, especially those suffering from respiratory illness.

Most homes and buildings have multiple sources that contribute to indoor air pollution, and the cumulative effects of the sources may pose a serious health threat. The most common pollutant sources include oil, gas, kerosene, coal, wood, asbestos-containing insulation, tobacco, molds, lead, and radon. Prolonged exposure to tobacco, radon, asbestos and other known carcinogens can put one at serious risk of developing certain forms of cancer. If too little outdoor air enters a home, pollutants can accumulate to levels that can pose health and comfort problems.

Some of the short-term effects of indoor air pollution include irritation to the eyes, nose and throat, and upper respiratory infections such as bronchitis and pneumonia. Long-term health effects can range from respiratory disease, lung cancer, heart disease, and damage to the brain and nervous system. As with most environmental pollutants, adverse health effects depend upon both the dose received and the duration of exposure. The combination of these factors, as well as an individual's particular sensitivity to specific substances, will determine the potential health effect of the pollutant on that individual.

NATIONAL SCALE AIR TOXICS ASSESSMENT BY THE USEPA

Air Toxics are emitted from a variety of sources other than point sources. In February 2006, EPA released the results of the National Scale Air Toxics Assessment (NATA). The purpose of the national-scale assessment is to identify and prioritize air toxics, emission source types and locations which are of greatest potential concern in terms of contributing to population risk. The national-scale assessment includes 177 pollutants plus diesel particulate. The assessment includes four steps that focus on the year 1999:

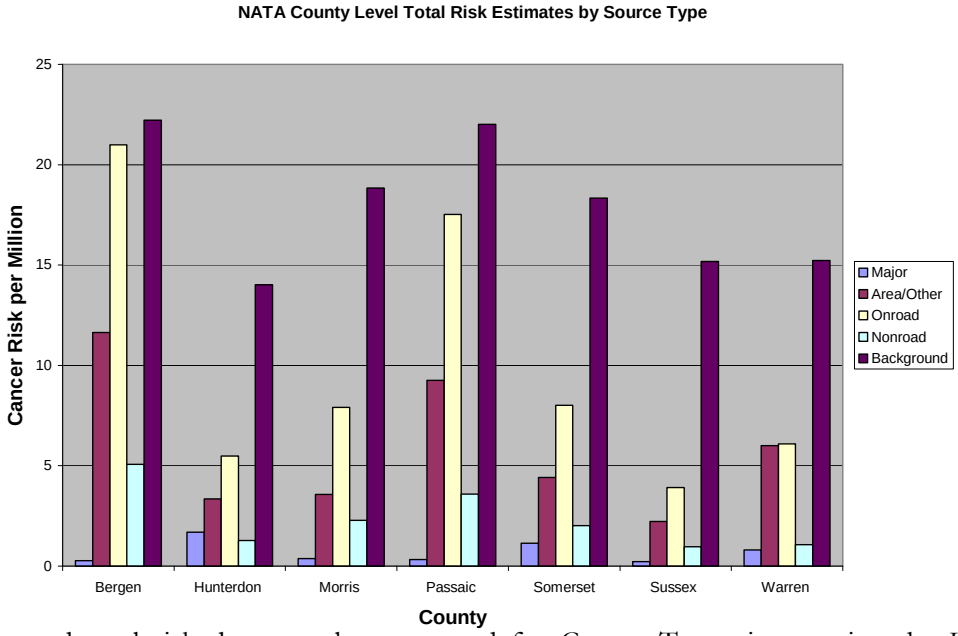
1. Compiling a national emissions inventory of air toxics emissions from outdoor sources.
2. Estimating ambient concentrations of air toxics across the United States.
3. Estimating population exposures across the United States.
4. Characterizing potential public health risk due to inhalation of air toxics including both cancer and non-cancer effects.

Data for potential cancer health risks estimated from step four above are presented in Figures 10 and 11, and were obtained from EPA. 41Impacts are estimated for five different source types: Major, Area/other, On Road, Non Road and Background. Units for the cancer risk estimate are expressed as a risk per 1 million individuals. Results show that background concentrations and on road sources contribute the most to cancer risk in the Highlands Region.

[40] U.S. Environmental Protection Agency, Indoor Air Quality. "The Inside Story: A guide to Indoor Air Quality"

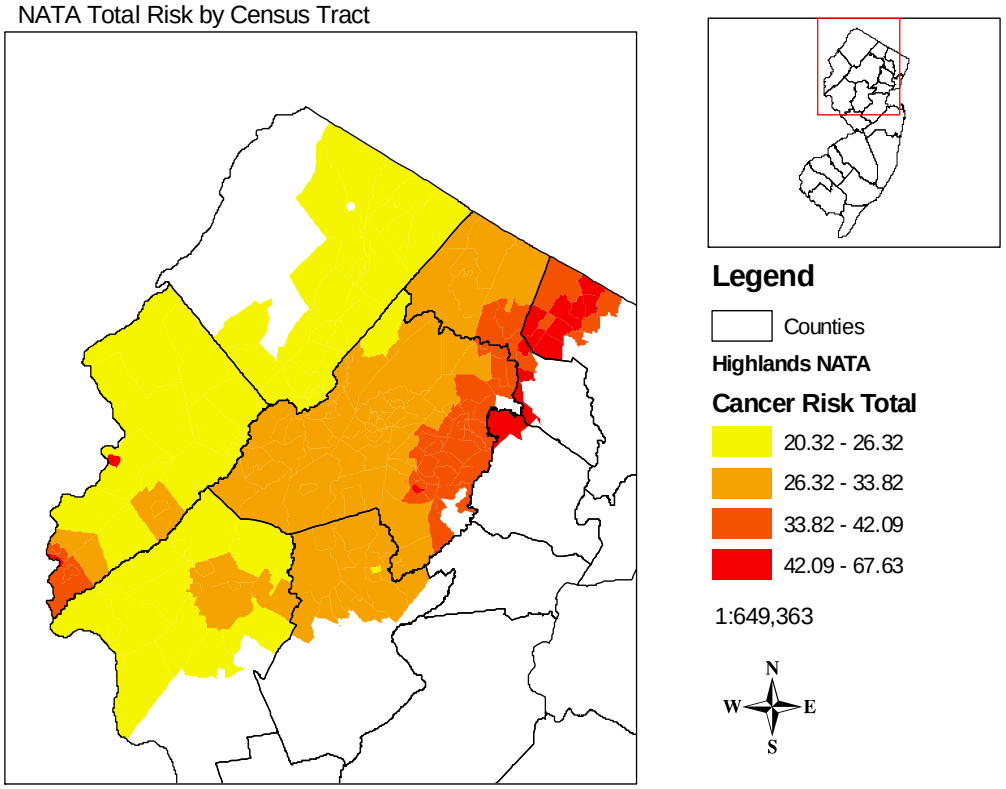
[41] http://www.epa.gov/ttn/atw/nata1999/tables.html

Figure 10



Results of estimated total risk data are also presented for Census Tracts intersecting the Highlands Region. The risks levels used to select the color ranges were calculated using the natural break function in ArcMap 9.1. Risk levels are generally the highest in the more developed areas of the Highlands Region and are generally attributed to background and on road sources. Tracts near two of the major point sources in Phillipsburg and Belvidere show smaller areas of increased risk in Warren County.

Figure 11



AIR QUALITY CONTROL MEASURES

FEDERAL PROGRAMS AND INITIATIVES

Several federal control measures to reduce air emissions are being phased-in beginning in 2002. Specifically, the Tier II Onroad Light Duty Standards for gasoline vehicles and the Onroad Diesel Emission Standards for diesel vehicles provide significant reductions of VOC, NO_x and $PM_{2.5}$. The measures are:

- Onroad Diesel Emission Standards and Ultra Low Sulfur in Fuel - New onroad diesel emission standards will take effect beginning with model year 2007 vehicles, but will not apply to existing pre-2007 vehicles. Refineries will convert the majority of their onroad fuel production to ultra low sulfur fuel containing 15 ppm of sulfur in 2006, with full production expected in 2010.
- Nonroad Diesel Emission Standards and Ultra Low Sulfur in Fuel - New nonroad diesel emission standards will be phased for model year 2008 to 2014 vehicles. Refineries will convert their nonroad fuel production to low sulfur fuel containing 500 ppm of sulfur in 2007 and then reduce the sulfur content even further (to ultra low sulfur or 15 ppm) in 2010.
- Tier II Onroad Light Duty Vehicle Emission Standards and Low Sulfur Gasoline New Tier II standards will phase-in beginning in 2004.
- Nonroad Spark Ignition Engine Standards (small, large and marine) - New engine standards for nonroad spark ignition engines will phase-in beginning in 2007.
- Clean Air Interstate Rule (CAIR) The USEPA promulgated the CAIR on May 12, 2005, in an attempt to address the interstate transport of ozone and fine particulate precursors. The Federal rule requires emissions reductions of SO_2 and NO_x; SO_2 and NO_x are precursors to PM and NO_x is a precursor to ozone. CAIR has an annual and ozone season NO_x program; both programs require reductions in NO_x beginning in 2009 through 2014 with further reductions beginning in 2015. CAIR also has an annual SO_2 program, which requires reductions in SO_2 beginning in 2010 through 2014 with additional reductions beginning in 2015.
- Federal Interagency Committee on Indoor Air Quality (CIAQ) EPA established the CIAQ to coordinate the activities of the Federal Government on issues relating to indoor air quality.
- The U.S. Green Building Council (USGBC) is the nation's foremost coalition of leaders from every sector of the building industry working to promote buildings that are environmentally responsible, profitable and healthy places to live and work The building industry is increasingly focused on making its buildings greener, which includes using healthier, less polluting and more resource-efficient practices. Improving indoor air quality by reducing pollutant concentrations and enhancing conditions that affect indoor health, is an essential component to a green building,
- The U.S. Environmental Protection Agency is tackling the problems associated with maintaining building indoor air quality through its Indoor Environments program which uses integrated, whole building approaches to protect occupant health while saving energy and money. The program focuses on major building types including offices and institutional buildings, schools, homes, as well as major cross-cutting indoor air quality issues like mold and moisture.

STATE PROGRAMS AND INITIATIVES

Since 2002, New Jersey has implemented several initiatives to reduce NO_x and VOC emissions and improve air quality. These initiatives are currently in effect or will take effect in the near future.

CLEAN CAR LEGISLATION

Automobiles in New Jersey contribute 40 percent of the pollution that diminishes our air quality, and more than 80 percent of the airborne carcinogens. For that reason, reducing air pollution from automobiles is vital to clean air.

In January 2004, legislation to bring New Jersey the cleanest cars available in the United States was

signed. The legislation adopted the California Low Emission Vehicle (LEV) 2 Program. Cleaner cars in New Jersey will reduce automotive emissions of NO_x and other ozone precursors such as VOCs. The legislation requires the NJDEP to begin implementing the LEV 2 program in 2009. By 2025, automobile emissions of NO_x, VOCs, and also air toxics are projected to be about 20 percent lower than they would have been without the LEV 2 program.

The legislation achieves these reductions by requiring carmakers to produce approximately 40,000 gas electric hybrid cars and 128,000 super clean gasoline cars for sale in New Jersey beginning in 2009. For manufacturers that are already working towards these goals, the NJDEP will provide credits for cars sold between 1999 and 2009. Regulations for this program were recently adopted by New Jersey.

STATE INITIATIVES FOR INDOOR AIR QUALITY

The State of New Jersey provides oversight through its agencies on four major indoor air pollutants: radon, lead, asbestos, and mold. NJDEP is the designated agency for issues dealing with radon, which is a naturally occurring radioactive gas that is formed by the disintegration of radium. Radon is one of the heaviest gases and is considered to be a health hazard, impacting indoor air quality worldwide. In the Highlands Region 69 municipalities are at highest radon risk including all Highlands portions of Sussex and Warren Counties, and all of Hunterdon County with the exception of Union Township. These high risk areas are required by New Jersey Department of Community Affairs (NJDCA) to include radon preventative measures in the construction of new homes. NJDEP and USEPA recommend that every household test for radon, even in lower risk areas[42].

The New Jersey Department of Health and Senior Services (NJDOHSS) is the designated agency for issues relating to asbestos, lead, and mold. Asbestos is the name given to a number of naturally occurring, fibrous silicate minerals mined for their useful properties such as thermal insulation, chemical and thermal stability, and high tensile strength. When these fibers get into the air, they may be inhaled into the lungs, where they can cause significant health problems. In 1985, New Jersey became the first state in the nation to adopt a comprehensive policy which provided a rational, uniform approach to the management of asbestos issues. In addition, the NJDOHSS deals with Asbestos through its Lead and Asbestos Training and Certification Project. This program administers a statewide lead and asbestos training program to ensure a trained and competent workforce. This program provides outreach and technical assistance. It also provides oversight on the State asbestos examinations administered by private contractors.

The Asbestos Hazard Emergency Response Act (AHERA) was passed by Congress in 1986 and requires local educational agencies to inspect their schools for asbestos-containing building material. It also requires a management plan that makes recommendations for the reduction of asbestos hazards. Public school districts and nonprofit private schools are subject to AHERA requirements[43].

Mold is a type of fungi that grows on organic matter everywhere in nature as well as in man-made environments where humidity and temperature are often stable enough to foster the growth of mold colonies which are visible to the naked eye. Buildings often contain cellulose-based materials such as wood, cardboard, and paper facing on dry walls which can be food sources for molds. Some toxins produced by molds are known to be harmful to human health.

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[42] New Jersey Department of Environmental Protection, Radon Protection Program. *Information on Radon Testing and Mitigation* (2004). http://www.state.nj.us/dep/rpp/radon/index.htm

[43] New Jersey Department of Health and Senior Services, Environmental and Occupational Health. *Lead and Asbestos Training and Certification Project: General Information* http://www.state.nj.us/health/eoh/leadasb/

The DC NJDOHSS provides information on mold and mold remediation in New Jersey through its Indoor Environments Program. It provides education and outreach materials, consultation, technical assistance, and assesses exposure and hazard[44].

STATE INITIATIVES FOR CLIMATE CHANGE AND GREENHOUSE GAS REDUCTIONS

New Jersey is one of a handful of states that currently has adopted legislation that addresses climate change concerns and recognizes air quality and green house gas emissions. In July 2007 Governor Corzine signed legislation adopting proactive and ambitious goals for the reduction of green house gas emissions in New Jersey. The legislation calls for reducing greenhouse gas emissions to 1990 levels by 2020, approximately a 20 percent reduction, followed by a further reduction of emissions to 80 percent below 2006 levels by 2050. New Jersey is only the third state in the nation make greenhouse gas reduction goals law.

To reach this goal, the Commissioner of the Department of Environmental Protection (NJDEP) will work with the Board of Public Utilities (BPU), the Department of Transportation (NJDOT), the Department of Community Affairs (NJDCA) and other stakeholders to evaluate methods to meet and exceed the 2020 target reductions. The NJDEP Commissioner will make specific recommendations to meet the targets while taking into account the economic benefits and costs of implementing these recommendations. This evaluation will be done in conjunction with the state's pending Energy Master Plan, which will incorporate the new greenhouse gas reduction goal.

The State Energy Master Plan (52:27F-14) released by the Governor in 2008 requires that all levels of government plan and evaluate for energy efficiency and greenhouse gas reductions. The Main Goal of the Energy Master Plan is to empower the state of New Jersey to reduce projected energy use by 20% by 2020 and meet 20% of the State's electricity needs with Class 1 renewable energy sources by 2020. The combination of energy efficiency, conservation, and renewable energy resources, should allow New Jersey to meet any future increase in demand without increasing its reliance on non-renewable resources.

RECENT REGIONAL MEASURES WITH THE OZONE TRANSPORT COMMISSION

1. NO_x and Distributed Generation Memorandum of Understanding

Small diesel engines that generate electricity locally, known as "distributed generation," often emit large amounts of NO_x. For each kilowatt-hour of electricity that they generate, these diesel engines emit more than 200 times the NO_x that a modern combined-cycle electric generating unit emits. Worse yet, those NOx emissions frequently occur on those summer days when the weather is hottest, electricity demands are the highest, and ozone levels are the worst.

New Jersey worked with twelve other states and the District of Columbia that belong to the Ozone Transport Commission (OTC) to develop a Memorandum of Understanding (MOU) to reduce NOx emissions from distributed generation. The NJDEP adopted rules to set NO_x limits on existing diesel engines that generate electricity down to 200 horsepower (hp), the size of a powerful car engine, as well as new engines generating power down to 50 hp.

Statewide, controlling NO_x emissions from distributed generation and from other sources of NO_x will reduce emissions by about six tons per day by 2007.

At the same time the NJDEP adopted regulations to ease permitting requirements for clean distributed

[44] New Jersey Department of Health and Senior Services, Environmental and Occupational Health. *Indoor Environmental Health Project* (February 2002) http://www.nj.gov/health/eoh/tsrp/moldbulletin.pdf

electric generation, such as fuel cells and clean micro turbines. The NJDEP will be looking for similar strategies in the next two years to create emission reduction requirements for all size source operations, including relatively small sources, while at the same time creating incentives for new clean processes.

2. Regulations on Commercial and Consumer Products and Portable Fuel Containers

The NJDEP adopted model OTC rules on April 7, 2004, in order to control the emissions of VOCs and toxics from consumer products and to establish requirements that apply to persons who are manufacturers, distributors, suppliers and retailers of consumer products. The rules apply to certain chemically formulated consumer products that have VOCs in their formulation (such as hair spray, insecticides, and cleaners), as well as portable fuel containers (gas cans), from which VOCs may be emitted when gasoline or other fuels are poured into or out of the container or stored in the container. VOCs are a significant precursor to ozone formation.

The estimated statewide VOC emission reductions from the implementation of the consumer products portion of this proposal are 12 tons per day in 2007. The estimated statewide VOC emission reductions from the portable fuel container portion of this proposal are approximately six tons per day in 2007.

3. Regulations on Solvent Cleaning, Mobile Equipment Repair and Refinishing Operations and Gasoline Transfer Operations

On April 30, 2003, the NJDEP adopted model OTC rules establishing new requirements for solvent cleaning operations, mobile equipment repair and refinishing operations, and gasoline transfer operations, in order to prevent or decrease emissions of VOCs from these operations by requiring such changes as more efficient spray guns. The estimated statewide VOC emission reductions from the implementation of the solvent cleaning operation portion of these rules are four tons per day by 2005. The estimated statewide VOC emission reductions from implementation of the surface coating operations at mobile equipment repair and refinishing facilities portion of these rules are nine tons per day by 2005. The estimated statewide VOC emission reductions from the implementation of the gasoline transfer operations portion of these rules are approximately 14 tons per day by 2007.

4. Architectural Coatings and Consumer Products

In July 2003, the NJDEP adopted model OTC rules that established standards for architectural coatings (paints, varnishes, stains and traffic coatings) for manufacturers, suppliers, distributors, retailers and persons who apply architectural coatings. The estimated statewide VOC emission reductions from implementation of these rules are 25 tons per day by 2005.[45]

FUTURE REGIONAL MEASURES

NJDEP is analyzing regional and state specific emission control measures, which may be required in order for the State to attain the ozone and PM2.5 NAAQS. New Jersey is a member of the following regional air quality associations: Ozone Transport Commission (OTC), Northeast States for Coordinated Air Use Management (NESCAUM), and Mid-Atlantic Regional Air Management Association (MARAMA).

The OTC is drafting new model rules in the following categories:

- Consumer Products
- Portable Fuel Containers

[45] http://www.state.nj.us/dep/ipoca/ozone_nj.htm

- Industrial Adhesives

The OTC is developing regional Reasonable Available Control Technology measures in the following categories:

- Asphalt Paving
- Asphalt Production
- Industrial, Commercial and Institutional Boilers
- Cement Kilns
- Glass Manufacturing

In addition, other regional control measures that are under consideration by the OTC include:

- Electric Generating Units (EGUs)
- EGU - High Electrical Demand Day Units

Regional control measures that are under consideration by NESCAUM and MARAMA include:

- Lower Sulfur Residential Heating Oil
- Petroleum Refinery Operations
  - Fluid Catalytic Cracking Units and Fluid Coking Unit
  - Boilers and Process Heaters
  - Flares
  - Equipment Leak and repair

NEW JERSEY SPECIFIC MEASURES

1. Diesel Retrofit Legislation

The new Diesel Risk Reduction Law, Public Law 2005, c. 219, enacted on September 7, 2005, is a first step toward addressing an urgent public health issue: controlling particulate matter from diesel-powered vehicles. Diesel emissions contain more than 40 known and probable carcinogens, including fine particles, commonly called soot. These pollutants are known to cause or exacerbate asthma, bronchitis, lung cancer, heart disease and premature death. By reducing exposure to diesel particulates through retrofits to vehicles and the use of ultra low sulfur diesel fuel, New Jersey can save lives and reduce health care costs. In addition, controls on emissions from school bus engines are expected to significantly reduce the high levels of particulates that children are exposed to while riding on school buses each day. In total, these reductions may enable the avoidance of up to 150 premature deaths each year and save up to $1.4 billion in health care and related costs annually Statewide. Because voters approved a constitutional amendment on November 8, 2005 to temporarily reallocate a portion of revenue from the Corporate Business Tax to reimburse vehicle owners, there will be no cost to vehicle owners to install retrofit technology. The requirements of the law apply to vehicle owners statewide, including the Highlands Region.

Most gasoline-fueled vehicles have control technologies like catalytic converters that reduce harmful emissions of air pollutants. Diesel vehicles do not currently have these emission controls, so aftermarket "retrofits" have been developed that can be installed on existing diesel vehicles. These include diesel particulate filters, diesel oxidation catalysts, and others that are attached at the tailpipe to filter pollutants. Another technology is a closed crankcase system (similar to a PCV valve on cars) that is installed on the engine crankcase to prevent diesel exhaust from seeping into the cabin of vehicles like school buses.

Under the law, all school buses, publicly & privately owned, will be required to install closed crankcase technology within two years of the effective date of the regulations adopted by NJDEP (estimated to be February 2007). The NJDEP plans to simultaneously perform a study to determine if emissions from the bus tailpipe are also significantly affecting the air quality inside a school bus. If so, tailpipe emission

controls may be required. Second, the following categories of vehicles are required to install tailpipe controls to reduce particulate emissions from their vehicles: private transit buses; public transit buses; garbage trucks that are publicly owned; garbage trucks that are privately owned and used in a public contract; publicly owned on-road vehicles such as dump trucks; and publicly owned non-road equipment such as bulldozers. Installation of retrofit technology will be phased in over ten years, based on availability of funding from the Corporate Business Tax.

2. Other New Jersey State Specific Control Measures Under Consideration

The NJDEP intends to focus future statewide control measures on electric generating units used to meet peak electric demand, also called peaking units that will lower emissions on the hottest days when electric demand and air pollution levels are the greatest. This, and other regionally developed and adopted air pollution control strategies, will help reduce the transport of air pollutants into the Highlands Region from other areas of our country.

NJDEP is currently considering control measures for wood smoke due to the growing trend for homeowners to burn wood to ease the cost of heating. As usage has increased, many homeowners have filed complaints against their neighbors and have contacted local, county and state officials for relief. Citizens have indicated that they are experiencing health related issues due to the smoke. Wood smoke contains harmful chemical substances such as CO, NO_x, VOCs, dioxin, and inhalable PM. Some of the VOCs are irritating, toxic, and/or cancer causing. One of the biggest human health threats from smoke, indoors or outdoors, comes from PM. Wood smoke PM is composed of wood tars, gases, soot, and ashes. Toxic air pollutants are a potentially important component of wood smoke. A group of air toxics known as polycydic organic matter includes potential carcinogens such as benzo(a)pyrene.[46]

Since wood smoke has caused health-related complaints and contributes significantly to PM2.5 levels, control measure strategies addressing the control of wood smoke at the local level in order to reduce nuisance complaints are being considered by NJDEP, at the state level to designate no burn days, and at the federal level to set standards for wood burning equipment[47]

NEW SOURCE REVIEW

The New Source Review (NSR) requirements of the Clean Air Act offer one of the most powerful tools to reduce air pollution and one of the clearest examples of federal rollbacks that jeopardize the abilities of states to reduce emissions of several types of air pollutants. NSR requires a facility to install the best available control technology (BACT) for air pollution when it undergoes an upgrade or other modification.

In 2002 and 2003, the USEPA all but eliminated NSR for existing facilities, bringing much of the progress toward settling NSR cases to a halt. In effect, these changes allow many polluting facilities to operate indefinitely without ever cleaning up their emissions.

The new rules encourage the owners of these plants to restore these plants so that they can run (and pollute) far more than their current condition allows. Restoring the old plant will be cheaper than building a new plant, because the new plant will require more money to build and to operate the air pollution controls that the old plant need not install.

New Jersey joined about a dozen other states in appealing the rulemaking modifications to the NSR

[46] http://www.epa.gov/woodstoves/healtheffects.html

[47] http://www.nj.gov/dep/airworkgroups/docs/wps/HR007_fin.pdf

rules. Federal courts have so far listened to the states, overturning the USEPA rule modification that provided exemptions for replacement of equipment on December 24, 2003.

Despite the negative implications of these changes for air quality, the USEPA has stated that it will propose additional revisions to the NSR rules. The NJDEP is concerned that these revisions will relax other elements of the existing rules.48 NJDEP will continue to challenge the USEPA on NSR rule relaxations and pursue NSR violations both in New Jersey and in other states, which affect New Jersey's air quality.

TECHNICAL FINDINGS

By working to promote development patterns that reduce mobile and stationary sources of air pollution, and the use of alternative and efficient transportation systems and the use of renewable energy, air pollution can be reduced. The following is a summary of the technical findings found in this report with respect to air quality in the Highlands Region:

- The entire Highlands Region is classified as non-attainment for the 8-hour ozone NAAQS, four counties in the Highlands Region are designated non-attainment for the $PM2_{.5}$, and special air pollution concerns of the Warren County due to the non-attainment area for SO_2.
- Coordinated planning at all levels of government can be promoted to support land and capital facility development, energy use reduction and redevelopment in order to meet NAAQS attainment and the Energy Master Plan. Regional-interstate coordination of attainment of NAAQS can be supported through research and implementation of regulatory, land use development, and transportation programs.
- Implementing resource protection standards can provide for the protection of air quality during site plan review. An evaluation of indoor air toxic concerns such as, radon, volatile organic compounds, and mold as well as an evaluation of energy efficiency building site design, NAAQS and ambient air toxics and hazardous air pollutants can be encouraged for all development activities.
- Diesel Retrofit Law guidelines can be developed in order to reduce SO2 and other diesel pollutants; and municipalities and counties can include them in a Circulation Plan element. Components of such an element should be consistent with policies promoting center-based growth and mixed-use development as a means to reduce automobile dependency, vehicle trip length and duration, and alternative modes of transportation. Development regulations should support land use planning decisions support the reduction of air pollutant production through reduction of vehicle trips, promote recycling of waste materials, and the use of green and renewable energy sources. County transportation plan that supports local and regional land use planning as an integral component will serve as a means to reduce vehicular emissions and provide opportunities for increased transit, car-pool or ride-share programs, and pedestrian and bike access.
- Municipal ordinances can be adopted to implement control measures for wood smoke and support "no burn" days as indicated by the NJDEP Bureau of Air Quality in order to reduce harmful pollutants.
- Air quality initiatives such as the 2004 Clean Car Legislation, the National Scale Air Toxics Assessment by the USEPA and the NJDEP Release and Pollution Prevention Database can be supported as a means to evaluate point sources for air toxic releases and the need for future monitoring locations. Support NJDEP efforts to reduce air emissions in Warren County due to power plant air pollution would have a positive impact on regional air quality.
- Educational programs can be developed targeting air quality concerns and initiatives for counties, municipalities, and stakeholders can also help to reduce green house gases, carbon footprints and air pollution. Such initiatives might include reducing indoor air contaminates from consumer products, wood burning stoves, storage and appropriate disposal of hazardous and flammable materials, energy

[48] http://www.state.nj.us/dep/ipoca/new.htm

efficient and green building technology and additional assessment of radon and indoor air quality by local health departments.

- In coordination with the NJDEP, and NJDOT, a region-wide initiative can be developed in order to support Clean Air Act, Global Warming Response Act, Energy Master Plan and NAAQS attainment in the Highlands Region. The program would be geared towards advancement and support of region-wide land use development patterns, energy audits for energy reduction measures, stationary source reduction, and transportation policies that promote the overall reduction of green house gases and air pollutants. Coordination with interstate agencies and other identified technical resources in support of the State Implementation Program and region-wide air quality initiatives.

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REFERENCES

Alewell, C., B. Manderscheid, H. Meesenburg, and J. Bittersohl, 2000, Is acidification still an ecological threat, Nature, 407, 856-857.

New Jersey Clean Air Council, New Jersey Clean Air Council 2006 Public Hearing report, viewed August 2006 at: http://www.nj.gov/dep/cleanair/hearings/phr06.pdf

New Jersey Department of Environmental Protection (NJDEP), April 2004. In Pursuit of Clean Air, A Review of State and Federal Policies Affecting New Jersey's Air Quality.

NJDEP, State Implementation Plan (SIP) Revisions for the Attainment and Maintenance of the 8-Hour Carbon Monoxide National Ambient Air Quality Standard, 1-Hour Ozone National Ambient Air Quality Standard, and Fine Particulate Matter National Ambient Air Quality Standard; and the 2002 Periodic Emission Inventory

NJDEP, DEP Dataminer, viewed August 2006 at: http://www.nj.gov/dep/opra/online.html

NJDEP, Bureau of Air Quality Planning, Emission Statement Information Page, viewed August 2006 at: http://www.state.nj.us/dep/aqm/es/emission.htm

NJDEP, Workgroup Recommendations and Other Potential Control Measures, Homes and Restaurants Workgroup, viewed August 2006 at: http://www.nj.gov/dep/airworkgroups/docs/wps/HR007_fin.pdf

NJDEP, Workgroup Recommendations and Other Potential Control Measures, Homes and Restaurants Workgroup, viewed August 2006 at: http://www.nj.gov/dep/airworkgroups/docs/wps/HR009_fin.pdf

NJDEP, Reducing Air Pollution Together Initiative, viewed August 2006 at: http://www.nj.gov/dep/airworkgroups/index.html

Spiro, Thomas, and William Stigliani, 2003, Chemistry of the Environment, 2nd Edition, Prentice Hall, Upper Saddle River, NJ 07458, page 279.

Sprenger, Mark, A. McIntosh, and T. Lewis, 1987, Variability in Concentrations of Selected Trace Elements in Water and Sediment of Six Acidic Lakes, Arch. Environ. Contam. Toxicol. 16, 383-390.

Sprenger, Mark, Alan McIntosh, and Stephanie Hoenig, 1988, Concentrations of Trace Elements in Yellow Perch (Perca flavescens) from Six Acidic Lakes, Water, Air, and Soil Pollution, 37, 375-388.

United States Environmental Protection Agency, (USEPA), Technology Transfer Network, National Ambient Air Quality Standards, viewed August 2006 at: http://www.epa.gov/ttn/naaqs/

USEPA, Six Common Air Pollutants, viewed August 2006 at: http://www.epa.gov/air/urbanair/nox/chf.html

USEPA, Air Pollution Emissions Overview, viewed August 2006 at: http://www.epa.gov/oar/oaqps/emissns.html#about

USEPA, National Ambient Air Quality Standards, viewed August 2006 at: http://epa.gov/air/criteria.html

USEPA, Air Trends, Sulfur Dioxide viewed August 2006 at: http://www.epa.gov/air/airtrends/sulfur.html

USEPA, Air Trends, More Details on Sulfur Dioxide - Based on Data through 2002, viewed August 2006 at: http://www.epa.gov/air/airtrends/sulfur2.html

USEPA, Visibility, viewed August 2006 at: http://www.epa.gov/oar/visibility/what.html

USEPA, Six Common Air Pollutants, Health and Environmental Impacts of Ground-level Ozone, viewed August 2006, http://www.epa.gov/air/urbanair/ozone/hlth.html

USEPA, Six Common Air Pollutants, Health and Environmental Impacts of NO_x, viewed August 2006 at: http://www.epa.gov/air/urbanair/nox/hlth.html

USEPA, Particle Matter, Health and Welfare, viewed August 2006 at: http://www.epa.gov/oar/particlepollution/health.html

USEPA, Fine Particle ($PM_{2.5}$) Designations, viewed August 2006 at: http://www.epa.gov/pmdesignations/faq.htm#2

USEPA, Clean Burning Woodstoves and Fireplaces, Health Effects of Woodsmoke, viewed August 2006 at: http://www.epa.gov/woodstoves/healtheffects.html

USEPA, Clean Burning Woodstoves and Fireplaces, viewed August 30, 2006 at: http://www.epa.gov/woodstoves/basic.html

USEPA, Boating Pollution Prevention Tips, viewed August 2006 at: http://www.epa.gov/otaq/boat-fs.htm

Yoon, Carol K., 1999, Report on acid rain finds good news and bad news: sulfate levels drop, but acidity continues, NY Times, October 7, 1999.